Paper 1 Pink

22nd NATIONAL CERTIFICATION EXAMINATION
FOR
ENERGY MANAGERS & ENERGY AUDITORS - JULY, 2022

PAPER - 1 : GENERAL ASPECTS OF ENERGY MANAGEMENT & ENERGY AUDIT

Date : 30.07.2022 Timings : 09:30-12:30 HRS Duration : 3 HRS Max. Marks : 150

Section – I: OBJECTIVE TYPE **Marks: 50 x 1 = 50**

1.	Energy security measure includes_____. a) fully exploiting domestic energy resources b) diversifying energy supply source c) substitution of imported fuels for domestic fuels to the extent possible d) **all of the above**
2.	The process of capturing CO_2 from point sources and storing them is called_____. **a) carbon sequestration** b) carbon sink c) carbon capture d) carbon adsorption
3.	The retrofitting of a variable speed drive in a plant costs Rs 2 lakh. The annual savings is Rs 0.4 lakh. The maintenance cost is Rs. 0.05 lakh/year. The return on investment is a) 25% b) 22.5% c) 24% **d) 17.5%**
4.	2000 kJ of heat is supplied to 500 kg of ice at 0^oC. If the latent heat of fusion of ice is 335 kJ/kg then the amount of ice in kg melted will be _____. a) 1.49 b) 83.75 **c) 5.97** d) None of the above
5.	The number of moles of water contained in 27 kg of water is_____. a**)** 5 b) 3 c) 4 d)**1.5**
6.	Which of the following GHGs has the longest atmospheric life time? a) CO_2 b) CFC c) Sulfur Hexafluoride (SF_6) **d) perfluorocarbon (PFC)**
7.	An indication of sensible heat content in air-water vapour mixture is a) wet bulb temperature c) density of air b) dew point temperature **d) dry bulb temperature**
8.	Which of the following comes under mandatory labeling program a) Diesel Generators b) Ceiling fan **c) Tubular Fluorescent Lamps** d) Pumps
9.	Find the future value of Rs. 1,000 at an interest rate of 10% in 10 years' time.

	a) **Rs. 2,594** b) Rs. 386 c) Rs. 349 d) Rs. 10,000
10.	In a drying process, moisture is reduced from 50% to 30%. Initial weight of the material is 100 kg. Calculate the weight of the final product in kg a) 80 b) 86 **c) 71.4** d) 74.3
11.	Energy intensity is the ratio of _____. a) Fuel consumption / GDP b) GDP/fuel consumption c) GDP/ energy consumption d**) Energy consumption / GDP**
12.	As per primary commercial energy consumption mix in India, the fuel dominating the energy production mix in India is a) Natural gas b) Oil **c) coal** d) Nuclear energy
13.	An activity has an optimistic time of 15 days, a most likely time of 18 days and a pessimistic time of 27 days. What is the expected time? a) 60 days b) 20 days **c) 19 days** d) 18 days
14.	Bio-gas generated through anaerobic process mainly consists of a) Only methane b) **Methane and carbon dioxide** c) Only ethane d) None of these
15.	Which of the following is not a part of energy audit as per the Energy Conservation Act, 2001? a) Monitoring and analysis of energy use b) Verification of energy use c) Submission of technical report with recommendations **d) Ensuring implementation of recommended measures followed by review**
16.	Which of the following statements are true regarding simple payback period? a) Considers impact of cash flow even after payback period b) Takes into account the time value of money c) Considers cash flow throughout the project life cycle **d) None of the above**
17.	What percentage of the sun's energy can silicon solar panels convert into electricity? a) 30% **b) 15%** c) 75% d) 50%
18.	Non-contact speed measurements can be carried out by a) Tachometer **b) Stroboscope** c) Oscilloscope d) Speedometer
19.	The amount of energy transfer from a higher temperature to a lower temperature is measured in a) **kcal** b) Watt c) Watts per second d) none of the above

20.	The amount of electricity required to heat 200 litres of water from 30°C to 70°C through resistance heating is a)0.93 kWh **b) 9.3 kWh** c) 930 kWh d) 8 kWh
21.	A process requires 100 kg of fuel with a calorific value of 5000 kcal/kg for heating with a system efficiency of 83 %. The loss would be a) 235,000 kCal **b) 85,000 kCal** c) 103680 kCal d) 415,000 kCal
22.	The internal rate of return is the discount rate for which the NPV is a) Always positive b) Always negative c) negative or positive d) **None of the above**
23.	The producer gas consists of a) CO b) H_2 c) CH_4 d) **All of the Above**
24.	Which of the following with respect to fossil fuels is true? a) Reserve / Production (R/P) ratio is a constant once established b) R/P ratio varies every year with only changes in production c) R/P ratio varies every year with only changes in reserves **d) R/P ratio varies every year with changes in both production and reserves**
25.	Air velocity in the ducts can be measured by using _____ and manometer a) Orifice meter b) Bourden gauge **c) Pitot tube** d) Anemometer
26.	Which industry among the following is not a designated consumer as per EC Act-2001? a) Fertilisers b) Chlor alkali c) Cement **d) Sugar**
27.	Propane is an example of stored _____ energy a)Nuclear b) Radiant **c) Chemical** d) Mechanical
28.	Statement not applicable to TOD (Time of the Day) in electricity tariff structure? a) Higher energy charges during peak period b) It is an incentive to maximize off- peak consumption c) It is an incentive to minimize peak time power draw from the grid by consumers **d) It is a disincentive for Distribution Company**
29.	In a heat treatment furnace the material is heated up to 1053 K from ambient temperature of 303 K. Considering the specific heat of material as 0.125 kCal / kg °C, what is the energy content gained by one kg of material after heating? **a) 94 kCal** b) 250 kCal c) 350 kCal d) 100 kCal
30.	The top two commercial energy consuming sectors in our country are_____. a) Industry and Agriculture b) Agriculture and Transport c) Residential and Industry d) **Industry and Transport.**

31.	The quantity of heat required to convert one kg of a liquid into vapour without change of temperature is called a) latent heat of fusion b) specific heat c) sensible heat d) **Latent heat of Evaporation**
32.	Acid rain is caused by the release of which of the following components: a) **SOx and NOx** b) SOx and CO_2 c) CO_2 and NOx d) Ozone
33.	Inexhaustible energy sources are known as: a) Primary energy b) Secondary energy c) Commercial energy d) **Renewable energy**
34.	The energy consumed by a 55 kW motor loaded at 40 kW over a period of 4 hours is: a) 220 kW b) 220 kWh **c) 160 kWh** d) 160 kW
35.	3.6 units of electricity is equivalent to _____ of kCal of heat units: a) 680 b) 860 **c) 3096** d) 3600
36.	If feed of 100 tons per hour at 5% concentration is fed to a crystallizer, the rate in tons per hour of the product obtained at 25% concentration is equal to: a) 40 **b) 20** c) 25 d) 100
37.	Which of the following is not a common normalizing factor in industrial facilities? a) Input b) Output **c) Maintenance cost** d) Product type
38.	The technique not used for scheduling the tasks and tracking of the progress of energy management projects is called_____. a) CPM b) PERT c) Gantt chart **d) CUSUM**
39.	Which of the following statements about critical path analysis is true? **a) The critical path is the longest path through the network** b) The critical path is the shortest path through the network c) Tasks with float can never be a task on critical path d) none of the above
40.	Which of the following most closely represents the heat content of 1 kg of LPG: a) 8000 kilo Calorie

	b) 12500 kilo Joule c) **12500 kilo Calorie** d) 8000 kilo Joule
41.	Specific energy consumption is defined as: a) Energy consumption per month b) Annual energy consumption c) Energy consumed per unit of fuel burnt d) **Energy consumed per unit of production**
42.	The annual MTOE limit for chloroalkali industry to be a designated consumer is _____ a) 30000 b) 3000 c) 7500 d) **12000**
43.	As per ECBC, EPI calculation includes _____. a) Solar photovoltaic Energy b) Grid energy purchased c) captive DG power d) **b and C**
44.	The nodal agency at centre for implementing the Energy Conservation Act in India, is _____. a. Central Electricity Authority b. Central Electricity Regulatory Commission **c. Bureau of Energy Efficiency** d. National Productivity Council
45.	As per Energy Conservation Act, 2001 appointment of BEE Certified Energy Manger is mandatory for _____. a. All commercial buildings b. All State designated agencies c. All large Industrial consumers **d. All designated consumers**
46.	A list of instruments and what they measure are given below. Which is the incorrect among this list ? a. Gas analyzer – CO **b. Lux Meter- Lumens** c. Manometer- Pressure d. Tachometer – Speed
47.	The ISO Series pertaining to the Energy Management System is _____. a. ISO 9001 b. ISO 14001 c. ISO 27000

	d. ISO 50001
48.	"Toe" stands for_____. a) Total oil equivalent b) Tons of effluent c) Tons of energy equivalent **d) Tons of oil equivalent**
49.	Sensitivity analysis is an assessment of_____. a) Profits b) Losses **c) Risks** d) All of the above
50.	Micro hydro will generate _____ a) less than 10 kW **b) 11kW up to 100 kW** c) 101 kW to 2 MW d) None of the above

..... End of Section I .....

Section – II: SHORT DESCRIPTIVE QUESTIONS **Marks: 8 x 5 = 40**

(i) Answer all **Eight** questions
(ii) Each question carries **Five** marks

S-1.	a. Explain energy performance contracting and their types? 3 Marks b. Explain the role of ESCOS in energy performance contracting? 2 Marks
S-1.	Ans: a. Refer Guide Book 1- Pg 178 b. Refer Guide Book 1- Pg 177
S-2.	Calculate the Net Present Value over a period of 4 years for a project with an investment of Rs 70,000 at the beginning of the first year and another investment of Rs 70,000 at the beginning of the second year and fuel cost saving of Rs 65,000 in second year and Rs. 60,000 each in third and fourth year. The discount rate is 12%.
S-2.	Ans: NPV = –70,000 – (70,000/1.12) + [65,000/(1.12x1.12) + [60000/(1.12x1.12x1.12) + 60,000/(1.12 x1.12x1.12x1.12)] = –70000 –62,500 + [51,818 + 42707 + 38,131] =156
S-3.	The rating of a single phase electric geyser is 2000 Watts, at 230 Volt. Calculate: a) Rated current 1 Mark b) Resistance of the geyser in Ohms 1 Mark c) Actual power drawn in kW when the measured supply voltage is 210 Volts 3 Marks

S-3.	Ans: a)Rated Current of the Geyser, I = P/V= 2000/230 = 8.696 Ampere b)Resistance Value R = V/I = 230/8.696 = 26.45 Ohms c)Actual Power drawn at 210 Volts = (V/R)*V = (210/26.45)*210/1000 =1.67 kW or (210/230)^2 x 2000/1000 =1.67 kW
S-4.	What are ESCerts and explain the basis for their issuance and trading under PAT scheme?
S-4.	Refer Guide book-1 – Page no 40-41
S-5.	List any five equipment and appliances covered under the Standards and Labelling (S&L) Scheme of the BEE
S-5.	Refer Guide book-1 – Page no 37. Any five among 19 appliances under the S&L Scheme (4 mandatory and 15 voluntary)
S-6.	(i) What is Solar Constant and Solar Insolation? 2 Marks (ii) A 375 Watt solar panel of the size 1.20 m x 1.50 m is installed in a solar photovoltaic power plant on a roof top area of a structure having dimensions of 10 m x 15 m. What will be the panel conversion efficiency if the solar insolation is 1000 Watt per square meter? 3 Marks
S-6.	(a) Refer Guide Book 1- Pg 263 (b) Maximum power output (Pm) = 375 W Solar Insolation (E) = 1000 W/m^2 Area of the solar cell (A) = 1.2x1.5 = 1.8 m^2 Energy Conversion Efficiency (n) = ((Pm/E x A)) x 100 = (375/ (1000x1.8)) x 100 = 20.83 The panel conversion efficiency is 20.83%
S-7.	A sample of coal is found to contain 64% carbon and 24% ash. The refuse obtained at the end of combustion is analyzed and found to contain 8% carbon and the rest is ash. Compute the percentage of the original carbon unburnt in the refuse.
S-7.	Coal: Carbon=64%, Ash=24% Refuse: Carbon=8%, Ash= 92% Assuming basis of the coal as 100 kg. The key is, Ash amount remains same in refuse as well as coal. So, Mass of carbon in coal = 64 kg Mass of ash in coal = 24 kg Mass of ash in refuse = 24 kg So, Mass of refuse = (100/92) x 24 = 26.087 kg Mass of carbon is refuse = (8/100) x 26.087 = 2.087 kg Percentage of original carbon remaining unburnt is refuse = (2.087/64) x 100

	= 3.26 %
S-8.	A. Write a short note on enhanced greenhouse effect? 3 Marks b. An office replaces its existing lighting system comprising of 10 CFL (30 Watt each) with equal number of LED (10 Watt each). If the average use (operational hours per lamp) is 2000 hours per annum, calculate the annual energy savings, the annual monetary savings as well as the payback period. Take the cost of LED lamp as Rs. 60 per lamp and the tariff as Rs.9 per kWh. 2 Marks
S-8.	a) Refer guidebook-1, page no 242 b) Annual Savings in Energy (kWh) = 10 X (30-10) X 2000 / 1000 = 400 Annual Savings in Money (INR) = 400 X 9 = 3600 Total Investment = 60 X 10 = 600 Payback Period = 600 / 3600 = 0.16 years or 2 months

..... End of Section II .....

Section – III: LONG DESCRIPTIVE QUESTIONS **Marks: 6 x 10 = 60**

(i) Answer all **Six** questions
(ii) Each question carries **Ten** marks

L-1	A proposed project requires an initial capital investment of Rs. 100 Lakhs. The cash flows generated by the project are shown in the table below : Year: 0 | 1 | 2 | 3 | 4 Cash Flow (Rs.in Lakhs): 100 | 30 | 30 | 40 | 45 (a) If the cost of fund is available at 11% for the project, calculate internal rate of return (IRR) for the given project. (6 Marks) (b) What are the limitations of Return on Investment (ROI) technique? (2 Marks) (c) What are the advantages of Simple Payback period technique? (2 Marks)
L-1 S	(a) The internal rate of return is the value of 'r' which satisfies the equation: 0 = -100 + 30/ (1+r) + 30/ (1+r) ^2 + 40/ (1+r) ^3 + 45/ (1+r) ^4 To begin with, Taking r = 12% Then, RHS = -100 + 30/ (1+.12) + 30/ (1+.12) ^2 + 40/ (1+.12) ^3 + 45/ (1+.12) ^4 = -100 + 26.78+ 23.91+ 28.47 + 28.59 = 7.77

Taking r = 15%

Then, RHS = -100+ 30/ (1+.15) + 30/ (1+.15) ^2 + 40/ (1+.15) ^3 + 45/ (1+.15) ^4

= -100 + 26.08 + 22.68 + 26.30+ 25.72

= 0.78

Taking r = 16%

Then, RHS = -100 + 30/ (1+.16) + 30/ (1+.16) ^2 + 40/ (1+.16) ^3 + 45/ (1+.16) ^4

= -100 + 25.86 + 22.29 + 25.62 + 24.85

= -1.36

So, it is ascertained that value of 'r' lies between 15 and 16 and that too slightly towards 15.

Now, using interpolation method,

r = 15 + [(0.80) x (16-15) / (0.80– (-1.36)]

= 15.37

So, the internal rate of return (IRR) is 15.37%.

(b) Refer guidebook-1, page no 165

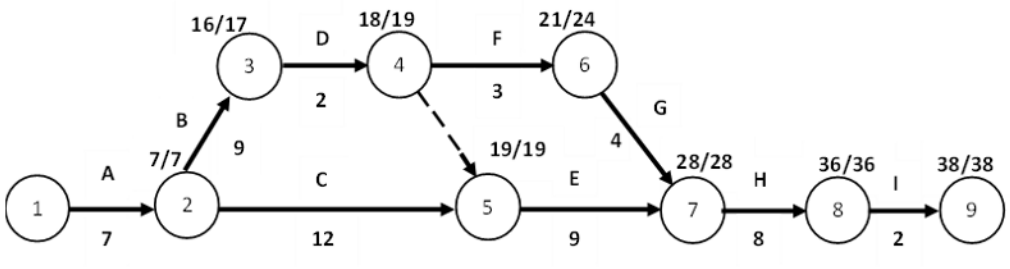
(c) Refer guidebook-1, page no 166

L-2 For the following activities, durations and predecessor relationships is given in the table below:

	Activity Description	Immediate Predecessor(s)	Optimistic (Weeks)	Most Likely (Weeks)	Pessimistic (Weeks)
1	A	-	4	7	10
2	B	A	2	8	20
3	C	A	8	12	16
4	D	B	1	2	3
5	E	D,C	6	8	16
6	F	D	2	3	4
7	G	F	4	4	4
8	H	E,G	4	8	12
9	I	H	1	2	3

Each 2 Marks

a) Draw the network
b) Calculate expected time for all tasks
c) Determine all possible paths and their estimated durations.
d) Identify the critical path.
e) For Task F, find out the Earliest Start (ES), Earliest Finish(EF), Latest Start (LS) and Latest Finish(LF).

L-2 S	a) Network  b) Expected duration of tasks (T_e) = (Optimistic + 4 x Most Likely + Pessimistic) /6 $T_eA = 7$ $T_eB = 9$ $T_eC = 12$ $T_eD = 2$ $T_eE = 9$ $T_eF = 3$ $T_eG = 4$ $T_eH = 8$ $T_eI = 2$ c) All the paths in the network and durations: Path 1 : A-B-D-F-G-H-I = 7+9+2+3+4+8+2 = 35 Path 2 : A-C-E-H-I = 7+12+9+8+2 = 38 Path 3 : A-B-D-E-H-I = 7+9+2+9+8+2 = 37 d) Path 2 : A-C-E-H-I is a critical path e) For Task F Earliest start of Activity = 18 Earliest Finish = 21 Latest Start = 21 Latest Finish = 24
L-3	The production through a paper machine is 300 tonnes per day (TPD). Inlet and outlet dryness to paper machine is 50% and 95% respectively. Evaporated moisture temperature is 80 °C. To evaporate moisture, the steam is supplied at 3.5 kg /cm^2. Latent heat of steam at 3.5 kg /cm^2 is 513 kcal/kg. Assume 24 hours/day operation and estimate the following: Each 5 Marks i) Quantity of moisture to be evaporated in kg/hr ii) Steam quantity required for evaporation in kg/hour. Note: Consider enthalpy of evaporated moisture as 632 kcal/kg.
L-3 S	Production through paper machine = 300 TPD = 12.5 TPH (tonnes per hour) Inlet dryness to paper machine = 50% Outlet dryness from paper machine = 95% i) Estimation of moisture to be evaporated:

Paper weight in final product = 12.5 x 0.95 = 11.875 TPH
Weight of moisture after dryer = (12.5-11.875) = 0.625 TPH
Paper weight before dryer on dry basis = 11.875 TPH
Weight of moisture before dryer = ((11.875) x (100/50)) – 11.875) = 11.875 TPH
Evaporated moisture quantity : 11.875 - 0.625 = 11.25 TPH = 11,250 kg per hour.

ii) Input steam quantity required for evaporation
Evaporated moisture temperature = 80 °C
Enthalpy of evaporated moisture = 632 kcal/kg
Heat available in moisture (sensible & latent) = 632 x 11,250 = 7,110,000 kcal /hour
For evaporation minimum equivalent heat available should be supplied from steam
Latent Heat available in supply steam (at 3.5 kg/cm^2 (g)) = 513 kCal/kg
Quantity of steam required = 7,110,000/ 513 kg per hour = 13,859.6 kg per hour=13.86 TPH.

L-4. a. Use CUSUM technique to develop a table and to calculate energy saving for 6 months period. For calculating total energy saving average production can be taken as 4500 MT per month. Refer to field data given in the table below: 6 Marks

MONTH	ACTUAL SEC KWH/MT	PREDICTED SEC kWh/MT
April	1301	1400
May	1308	1400
June	1315	1400
July	1320	1400
August	1325	1400
September	1355	1400

b. List any two ozone depleting substances (ODS) and Green House Gases (GHG). 4 Marks

A.

Month	Actual SEC	Predicted SEC	Sec Diff (Act-Predict)	CUSUM Saving
April	1301	1400	-99	-99
May	1308	1400	-92	-191
June	1315	1400	-85	-276
July	1320	1400	-80	-356
August	1325	1400	-75	-431
Sept	1355	1400	-45	-476

Saving in energy consumption over period of Six Months = 476 * 4500
= 21,42,000 kWh

	B. Refer Guide Book-1, Page no 239 and Page No 243
L - 5	Explain the following a. Comparative label 2 marks b. Endorsement label 2 marks c. Minimum energy performance standard 2 marks d. Explain the difference between standards and labelling 4 marks
	a. Comparative label - Refer Guidebook-1, Page no 36 b. Endorsement label - Refer Guidebook-1, Page no 36 c. Minimum energy performance standard - Refer Guidebook-1, Page no 36 d. Explain the difference between standards and labelling - Refer Guidebook-1, Page no 35 & 36
L - 6	Each 5 Marks a) List down any five energy audit instruments and parameters they are used to measure. b) List five energy security measures.
	a) Refer Guidebook-1, Page no 104 to 110 b) Refer Guidebook-1, Page no 20 to 22

..... End of Section III .....